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ABSTRACT

The School of Education of Syracuse University implemented EXPER SIM, a computer simulation program, in a graduate program in instructional technology. During a one-semester course each student planned a program of research, developed a proposal for at least one experimental study, collected simulated data using EXPER SIM, analyzed and interpreted the data, prepared a paper, and presented it at a mock convention. EXPER SIM was used to focus on the research process rather than on specific theory or constructs. Evaluation of the course showed that students felt EXPER SIM was an effective technical tool for learning experimental research concepts and processes. The authors make four recommendations to facilitate the use of EXPER SIM: documentation on systems and procedures for EXPER SIM should be provided; time and assistance in installing and implementing the program should be made available; a cookbook of practical examples for the novice model builder be useful; and problems of generating new models could be reduced by the development of general model subroutines. (CH)

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IMPLEMENTING AND EVALUATING 'EXPER SIM'

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Implementing and Evaluating EXPER SIM

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In the School of Education at Syracuse University we have implemented EXPER SIM in a graduate program in instructional technology. We have also developed resources to facilitate its use by students and faculty and have done some preliminary model-building and evaluation. I would like to share with you some of our views regarding problems and approaches to implementing and evaluating EXPER SIM and to offer several recommendations. Although our experience has only been with the MESS system on an IBM 370/155 computer, I expect that at least some of what I will have to say may be generalized to the LESS system and to other computer systems as well.

Implementing EXPER SIM

In the fall of 1973 I had developed and used a very simple data simulation system in our graduate reseach course in instructional technology. I was attempting to provide students, most of whom had little or no experimental research knowledge or experience, with an opportunity to plan studies related to problems in instructional technology, to analyze and interpret data for such studies, and to report and discuss the results, all in a period of 4-5 weeks.

In the spring of 1974 I learned of EXPER SIM and the possibility of receiving support from the EXXON Education Foundation to implement it. Needless to say, I was very interested, submitted a proposal to the Foundation and, in December 1974, received a grant.

Installing EXPER SIM

While awaiting word from the Foundation, I proceeded to acquire a computer tape of the MESS system and models from Dana Main at the University of Michigan. In the fall of 1974, John Hedberg and I began the process of installing MESS on Syracuse University's IBM 370/155 system and preparing for its use in the reseach course.

For those of you who have not had the good (or bad) fortune of using an IBM 360 or 370 system, let me simply understate the fact that it is not the easiest computer system to work with, especially if you are not very experienced in installing systems as sophisticated as MESS. Installation of MESS or LESS on an IBM 360 or 370 system may be more difficult than on most other large computers. For instance, the DEC-System 10 has a much more user-oriented operating system; installation on that computer should be relatively easy.

The initial set of problems which we encountered--perhaps the only real problems--related to the installation of the MESS system on the IBM computer. The

tape we received contained 37 files of programs, subroutines, and data, each of which had to be created and stored on the system. A number of the files contained programs or subroutines which needed modification before they could be compiled and linked together for use. The editing and link-editing of all these became a major task. A considerable amount of time was spent planning and trouble-shooting the organization of files and the sytem procedures necessary to modify, compile, link-edit, and store the MESS programs and subroutines. The organization of MESS that finally evolved is represented in Figure 1.

The actual modification of the programs and subroutines presented much less of a problem. Our greatest difficulty was getting working routines which the main supervisor program and some model subroutines could call to obtain time, date, and random number data from the computer's operating system.

Several months ago we sent a questionaire to 40 users of EXPER SIM asking for information about the installation and modification of MESS and LESS and about approaches to evaluating EXPER SIM. We received returns from 20 of the 40, of which 14 indicated they had to make modifications to the supervisor program to enable students and faculty to use MESS or LESS. In some cases the modifications reportedly went beyond those that were essential for running the supervisor. Some were made to take advantage of features of

the computers operating systems and others were aimed at improving the easy of use by faculty and students.

At Syracuse we have been able to make EXPER SIM easier for students and faculty to use by developing a psuedo-interactive system using APL, A Programing Language. For the student user, the interface eliminates the necessity of keypunching and submitting cards for batch processing while allowing access to EXPER SIM via remote terminals. It also prompts them for the input to EXPER SIM, assuring that the data are entered in the correct order. For the faculty user, the APL interface greatly simplifies the tasks of setting up and removing models, changing features of the system available to the student, and maintaining system security. In addition, the interface gathers a variety of data on the use of various models, data which may be used in the evaluation of the system (See Table 1).

Developing EXPER SIM Resources

Since adoption of EXPER SIM involves changes in the process and content of learning and instruction, some effort is required to adapt part or all the course in which EXPER SIM is to be used. Although we had begun using a research simulation strategy before acquiring EXPER SIM we found, nevertheless, that a substantial amount of preparation of resources remained! The course syllabus and schedule had to be revised and objectives and assignments had to be

traded-off; a students' handbook, modeled on one form the University of Michigan, had to be written and produced; and models and their adjunct materials had to be developed and tested.

We pursued model-building over a period of four to five months. If there is a second problem area, it is here in the early stages of model-building. Documentation, particularly with respect to the interfacing of model subroutine and supervisor program variables, leaves a great deal to be desired. Dana and I have discussed the need for an introductory model-building "cookbook", one with some nice simple "recipes" and explanations. Until one comes along for the novice model-builder, one will probably need the skills of a fairly good Fortran applications programmer to figure out what does what: and how.

Using EXPER SIM

EXPER SIM was fully implemented in our research course this past fall. Most of the class of 15 students, who have quite divergent undergraduate, graduate, and professional backgrounds, were beginning our doctoral program in instructional technology. After several introductory units on research methods and design concepts in experimental research had been begun, EXPER SIM was introduced. We started with a simple design exercise using IMP, the model based on the phenomenon of imprinting observed in young

fowl. This exercise provided everyone with an opportunity to try out the system, correct some technical and conceptual problems, and discuss the purposes and outcomes of EXPER SIM.

Then, about six weeks into the semester, the class was organized into a "research community" consisting of six research teams of 2-3 members. A common scenario presenting a research problem in instructional televison was given to each team member. After studying the scenario and searching, reviewing, abstracting, and discussing related television research, each team prepared and presented a plan for a program of research which would satisfy the demands in the scenario. Next, each team member developed a research proposal for a particular study within the team's program of research and "collected" the data using EXPER SIM.

Although all the teams used the same model, called BOOBTUBE, each team invoked a different simulation data set for the model when members ran their simulations. In this way we were able to effect different reseach outcomes for different teams. For example, some effect sizes, interactions, and amounts of missing data varied from team to team. The students had to recognize and explain these differences and, in several instances, had to modify their research plans and proposals.

A number of the students took advantage of the punched data output options of the system and, with some assistance from John Hedberg, used several programs in the SPSS statistical package to analyze their data.

By the end of the semester each student had participated in planning a program of research, developed a proposal for at least one experimental study, 'collected' simulated data, analyzed and interpreted it, prepared a paper reporting the study, and presented the paper at a mock convention.

In sum, our simulation approach has used EXPER SIM to focus on the research process rather than on a specific theory, construct, or phenomenon. There are, of course, other purposes and approaches to using EXPER SIM, most of which Dana Main has described here and elsewhere (Note 1).

Evaluating EXPER SIM

Just as there are a number of approaches to implementing EXPER SIM, so are there alternatives to evaluation. In our questionaire sent to EXPER SIM users, we asked several questions regarding evaluation methods and data. Eleven of the twenty users who responded reported that they had evaluated or were evaluating the effectiveness of EXPER SIM. A tally of responses to five other evaluation questions are presented in Tables 2 and 3.

A number of conditions and constraints will determine the types of evaluations possible and practical. The purposes and outcomes of the evaluation must also be considered in choosing the evaluation method. At Syracuse we have implemented EXPER SIM in only one course so far. Since there is only one section of this course, we have been limited to single group evaluation designs. However, in the early stages of implementation, multiple group designs most probably will fail to provide the user with the most valuable information, especially since so many things are undefined and uncontrolled in such 'true experiment' designs. Unless there is some urgency in demonstrating that EXPER SIM is more effective than some current, 'subjectively known' method, single group, formative evaluation designs seem more appropriate (Note 2).

Our single group approach has served our initial needs for formative evaluation data satisfactorily. A great deal of the information has come from comments and suggestions from students. For more formal evaluation data, we prepared and administered a number of pre- and post-treatment instruments, including a 25-item objective test on basic research and statistical concepts, a self-assessment on reseach competencies, a task to outline a proposal for an experimental research, and an end-of-semester course evaluation. Results of analyses of the objective test revealed expected, significant improvement. The analysis of the proposal outlines requires more time and effort them we

have had to give to it and, therefore, remains to completed.

The self-assessment instrument consisted of 21 of 25 research and evaluation competencies compiled and reported by Worthen (1975). Thirteen of the 21 competencies related most directly to EXPER SIM were used to cluster students with similar competency profiles at the end of the semester. The competency profiles consisted of assessments of knowledge and skills and experience for each competency on scales from 0 to 7 according to the scale values defined in Table 4. The results revealed there were two distinctly different groups of students at the end of the semester (Figure 2). While the groups did not differ with respect to experiences on either pre- or post-treatment assessment, they did differ substantially on most competencies with respect to skill and knowledge on both assessments. Despite differences in their (perceived) entering competencies, both groups perceived significant gains on most competencies. Most disappointing to us were the poor results on competencies 21, 22, and 23, a factor we must take into account in preparing students to use EXPER SIM next fall.

One interesting result we observed was the stability of group membership from pre- to post-treatment assessment. When group membership based on groupings with pre-treatment competency profiles was compared with group membership based on post-treat competency profiles, only one student changed

groups, moving from the lower (X) to the higher (O) competency group.

Finally, the end-of-semester course evaluations, which solicited written comments and suggestions on EXPER SIM, indicated that nearly every student felt that EXPER SIM was a viable and effective technology for learning experimental research concepts and processes.

Recommendations

I believe it is worthwhile to summarize our views on the implmentation and evaluaton of EXPER SIM within the framework of a number of recommendations to present and potential users.

1. Documentation on installation systems and procedures should be available.

Although installation systems and procedures will certainly require some modifications, I expect that in quite a few instances such documentation could save new adoptors a substantial amount of time, money, effort, and unnecessary work. This documentation should include information on the organization of files and system procedures for modifying and installing programs.

2. Obtain support and assistance in installing and implementing EXPERSIM.

The assistance of a graduate student skilled in applicatons programming and in computer systems operations can greatly lighten an otherwise heavy load for the faculty user. Assistance in developing the course, new models, and related materials and in aiding new users (students and faculty) also seems quite desirable; in most cases, probably necessary.

3. Allow enough time to install and test the system and to develop related resources.

I expect several man-weeks of work is the bare minimum required to set everything in order. In terms of our calendars, from several months to a semester or more may be needed to implement EXPER SIM in the classroom.

4. Expect model building to take a substantial amount of time and effort; then be pleasantly surprised and exceedingly grateful when it doesn't.

5. Plan and conduct both formative and summative evaluations of EXPER SIM.

A variety of alternatives are available to serve varying purposes. Although experiments on EXPER SIM may be conducted in some circumstances, perhaps the most valuable data at this stage of the development of the EXPER SIM pedagogy and technology will be that which serves formative evalution.

6. Assemble a "cookbook" of simple and practical programming examples, explanations, and tricks for the novice model-builder.

7. Develop several "general model" subroutines.

Several different general subroutines could be tailored to specific variables and relationships merely by changing the data in the files DATA and MINIT. This would greatly reduce the problems of generating new models.

Reference Notes

1. Main, D. B., Stout, R., and RaJecki, D. W. A pedagogical schema for the development and use of computer simulation technology. Paper given to Annual symposium of the National Gaming Council and conference of the International Simulation and Gaming Association, September, 1973.

2. Several experimental studies on EXPER SIM have been conducted at the University of Michigan. Among them: Nusslock, R. H., Kaplan, R. J., and Main, D. B. Causal critiques or active arguments?--A comparison of the use of computer data generators and journal article criticism in the science classroom. Department of Psychology, University of Michigan, Ann Arbor, Michigan.

Reference

Worthen, B. R. Competencies for educational research and evaluation. Educational Researcher, 1975, 4(1), 13-16.

Figure 1. Organization of MESS at Syracuse University

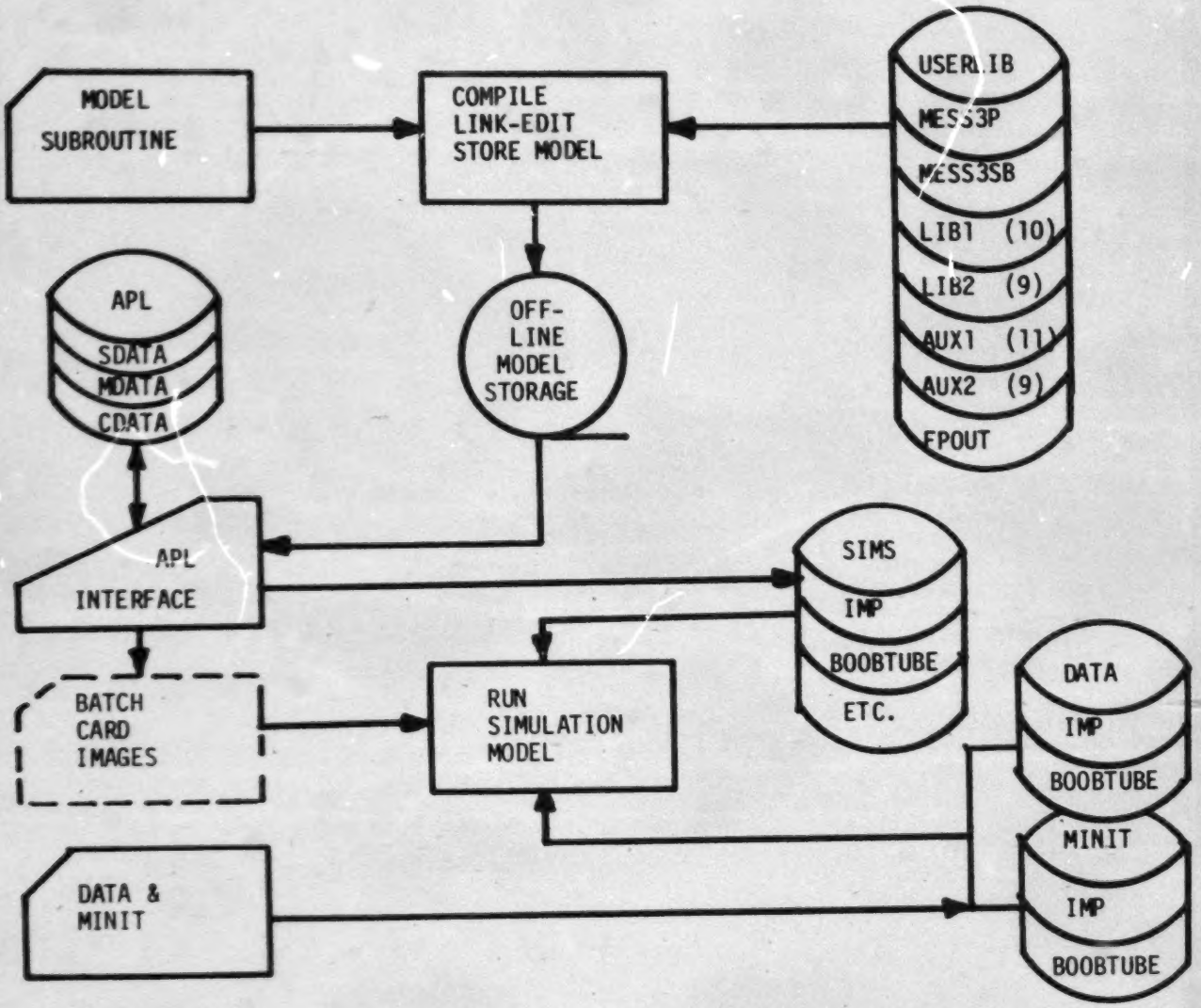


Table 1. Data Gathered Automatically with the APL Interface

03440000 SDATA

ACCOUNT	NAME	DATE	TIME	SIM	DATA	CONDS	MS/COND	JOB NO.	RESP TIME
03440000									
3440515									
	BERRIGAN	10/03/75	16.38.38	IMP	IMP	8	10	66290	00.06.08
3440565									
	TRABERT	10/04/75	16.02.40	IMPRINT	J	ITE	126	TRABERT	00.11.21
	TRABERT	10/06/75	16.45.40	IMP	IMP	3	24	67892	00.05.02
	TRABERT	11/18/75	21.19.56	BOOBTUBE	SUDY	12	40	07094	00.07.02
	TRABERT	12/05/75	23.14.16	BOOBTUBE	SUDY	8	40	21433	00.18.57
	TRABERT	12/05/75	23.30.06	BOOBTUBE	SUDY	8	40	21440	00.04.52
3440535									
	FISHER	10/06/75	10.18.51	IMP	IMP	3	24	67370	00.11.51
	"	10/06/75	10.56.35	IMP	IMP	3	24	67441	00.04.51
	FISHER	10/06/75	16.53.32	IMP	IMP	8	24	67904	00.05.59
	FISHER	10/07/75	09.55.01	IMP	IMP	8	24	68362	00.03.37
	FISHER	11/07/75	10.08.40	BOOBTUBE	TOCAMA	4	20	96400	00.03.12
	FISHER	11/07/75	15.21.46	BOOBTUBE	TOCAMA	4	20	96838	00.02.32
	FISHER	11/09/75	14.59.10	BOOBTUBE	TOCAMA	4	20	97613	00.04.01
	FISHER	11/11/75	09.20.25	BOOBTUBE	TOCAMA	4	20	99131	00.02.43
	FISHER	11/11/75	13.28.09	BOOBTUBE	TOCAMA	12	20	99570	00.03.53
	FISHER	11/12/75	10.41.29	BOOBTUBE	TOCAMA	12	20	00623	00.06.09
3440545									
	KAZLUSKY	10/06/75	15.21.33	IMP	IMP	6	20	67782	00.03.10
	KAZLUSKY	10/06/75	15.24.44	IMP	IMP	20	10	67790	00.04.54
	KAZLUSKY	10/06/75	15.28.01	IMP	IMP	18	10	67794	00.06.34
	TOCAMA	10/29/75	13.44.49	BOOBTUBE	TOCAMA	4	20	88037	00.03.51
	TOCAMA	10/29/75	13.52.13	BOOBTUBE	TOCAMA	4	20	88057	00.08.01

Table 2. Evaluation Designs and Measures

Summary Exper Sim Questionnaire

8. What "design" did you use to assess the effectiveness of Exper Sim?

_5_ single group design (post-treatment data only)

_4_ single group design (pre/post-treatment contrasts)

_4_ multiple group design (experimental/control groups)

9. What measures did you use to assess the impact of Exper Sim on student performance?

_4_ objective test(s)

_6_ competency demonstration

_7_ lab or project assignments

_9_ questionnaire

_1_ course grade

_9_ course evaluation

_11_ unsolicited comments from students

_5_ colleagial feedback

Table 3. Student Attitude and Numbers

10. What measures did you use to assess the impact of Exper Sim on student attitudes?

10 course evaluation

1 questionnaire

12 unsolicited comments from students

4 colleagial feedback

11. What level and number of students are using Exper Sim?

88 avg number of undergraduates (Range 10-500, Number of groups 12)

34 avg number of graduates (Range 5-100, Number of Groups 6)

12. Have you collected data on the frequency or extent of student use of various simulation models, research designs, etc.? 3 YES 16 NO (Please attach a brief summary of that data.)

Table 4. Directions for Self-Assessment

SELF-ASSESSMENT OF RESEARCH COMPETENCIES AND EXPERIENCES

Directions:

This self-assessment instrument is based upon a list of educational research and evaluation competencies synthesized by Worthen (1975). Refer to Worthen's article as you complete the assessment.

On a scale from 0-7 assess your current (a) research skills and knowledge and (b) previous experience. Consider the zero and odd scale values to mean the following, with the even scale values assuming intermediate meanings:

Scale Values

0 = None

1 = Some, but insufficient to plan/conduct an acceptable research study

3 = Sufficient to plan/conduct an acceptable research study with moderate guidance/ consultation

5 = Sufficient to plan/conduct an acceptable research study with occasional guidance/ consultation

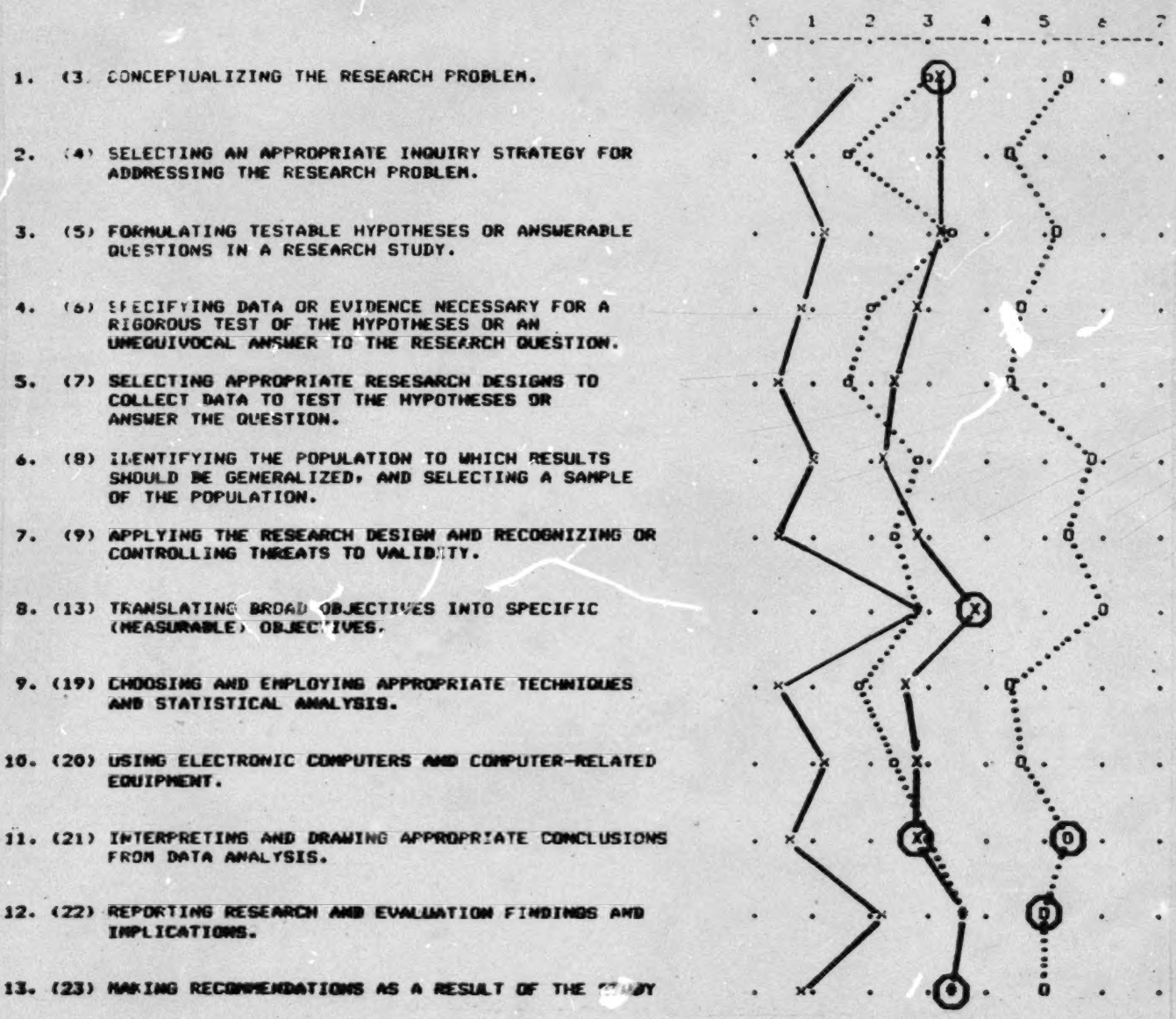
7 = Sufficient to plan/conduct an acceptable research study with minimal guidance/ consultation

An "acceptable research study" is one which meets published professional standards (e.g., journal or dissertation standards).

(Circle the appropriate value)

1. Obtaining information about an area to be researched.
   a.) SKILL/KNOWLEDGE: 0 1 2 3 4 5 6 7
   b.) PREVIOUS EXPERIENCE: 0 1 2 3 4 5 6 7
2. Drawing implications from results of prior research and practice.
   a.) SKILL/KNOWLEDGE: 0 1 2 3 4 5 6 7
   b.) PREVIOUS EXPERIENCE: 0 1 2 3 4 5 6 7
3. Conceptualizing the research problem.
   a.) SKILL/KNOWLEDGE: 0 1 2 3 4 5 6 7
   b.) PREVIOUS EXPERIENCE: 0 1 2 3 4 5 6 7

FIGURE 2. SELF-ASSESSMENT ON SKILLS & KNOWLEDGE: PRE- & POST-TREATMENT
(2 GROUPS: X=7, O=5, ⊕=BOTH GROUPS)


0 1 2 3 4 5 6 7
1. (3) CONCEPTUALIZING THE RESEARCH PROBLEM.
2. (4) SELECTING AN APPROPRIATE INQUIRY STRATEGY FOR ADDRESSING THE RESEARCH PROBLEM.
3. (5) FORMULATING TESTABLE HYPOTHESES OR ANSWERABLE QUESTIONS IN A RESEARCH STUDY.
4. (6) SPECIFYING DATA OR EVIDENCE NECESSARY FOR A RIGOROUS TEST OF THE HYPOTHESES OR AN UNEQUIVOCAL ANSWER TO THE RESEARCH QUESTION.
5. (7) SELECTING APPROPRIATE RESESARCH DESIGNS TO COLLECT DATA TO TEST THE HYPOTHESES OR ANSWER THE QUESTION.
6. (8) IDENTIFYING THE POPULATION TO WHICH RESULTS SHOULD BE GENERALIZED, AND SELECTING A SAMPLE OF THE POPULATION.
7. (9) APPLYING THE RESEARCH DESIGN AND RECOGNIZING OR CONTROLLING THREATS TO VALIDITY.
8. (13) TRANSLATING BROAD OBJECTIVES INTO SPECIFIC (MEASURABLE) OBJECTIVES.
9. (19) CHOOSING AND EMPLOYING APPROPRIATE TECHNIQUES AND STATISTICAL ANALYSIS.
10. (20) USING ELECTRONIC COMPUTERS AND COMPUTER-RELATED EQUIPMENT.
11. (21) INTERPRETING AND DRAWING APPROPRIATE CONCLUSIONS FROM DATA ANALYSIS.
12. (22) REPORTING RESEARCH AND EVALUATION FINDINGS AND IMPLICATIONS.
13. (23) MAKING RECOMMENDATIONS AS A RESULT OF THE STUDY

NOTE 1. NSD PRE- TO POST-TREATMENT FOR CIRCLED MEANS.